Appendix 9

Habitat Survey

Habitat data collection

The purpose of the habitat survey was to determine spatial proportions of the mesohabitat units in selected sections. The date and flow at the time of each survey are shown in Table 1 below. For each HMU, the location and size was determined with GPS and ArcPAD software in conjunction with high-resolution aerial photographs, creating a detailed map of selected sites on the river. The outlines of each HMU were drawn as geo-referenced polygons on a Hewlett-Packard iPAQ palmtop computer running ArcPAD software.

Within each HMU, mean column velocity, depth and estimated substrate were measured in seven random locations. The number of measurements was empirically chosen as the smallest statistically relevant quantity. Measurements for depth and mean column velocity were usually taken with a Dipping Bar (Jens 1968) in areas shallower than 1.0 m. For deeper locations a Marsh-McBirney Flo-Mate was used. The other physical attributes (below) were estimated for each unit (using three categories: absent, present, abundant) and entered into a GIS table associated with the corresponding polygon. For substrate definitions we referred to the choriotop classification system according to Austrian Standard ÖNORM 6232 (1995) (below).

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Table 1: Records of date and flow conditions corresponding to each hydromorphological survey are shown. Completed surveys (in yellow) include the flow conditions in cfs and cfsm at the Merrimack USGS flow gauge at the time of mapping. The formulas in the site cfsm conversions column are used to create the columns of data (green) approximating the cfsm values at each site. Flow conditions during snorkel and grid fishing surveys are also included.

Souhegan River HMU Survey Chart

	0.2 Mcfsm				0.5 Mcfsm				1 Mcfsm			
	Date	**cfsm**	**Mcfsm**	**Mcfs**	**Date**	**cfsm**	**Mcfsm**	**Mcfs**	**Date**	**cfsm**	**Mcfsm**	**Mcfs**
Site 1	9/7/2004	**0.16**	0.18	30	8/16/2004	**0.31**	0.42	72	6/23/2005	**0.65**	1.06	182
Site 2	9/7/2004	**0.16**	0.18	30	8/17/2004	**0.34**	0.46	79	4/21/2005	**1.69**	2.27	388
Site 3	9/8/2004	**0.07**	0.18	30	8/17/2004	**0.31**	0.46	79	4/22/2005	**1.78**	2.39	410
Site 4	9/8/2004	**0.07**	0.18	30	8/18/2004	**0.24**	0.39	66	4/22/2005	**1.84**	2.46	422
Site 5	9/8/2004	**0.10**	0.18	30	8/18/2004	**0.22**	0.39	66	6/23/2005	**0.58**	0.98	168
Site 6	9/8/2005	**0.09**	0.18	31	8/19/2004	**0.21**	0.34	59	6/24/2005	**0.78**	0.86	147
Site 7	9/7/2005	**0.09**	0.18	31	8/26/2004	**0.24**	0.38	65	6/25/2005	**0.71**	0.81	138
Site 8	9/7/2005	**0.10**	0.18	31	6/27/2005	**0.54**	0.64	110	7/20/2005	**0.90**	0.95	163
Site 9	9/22/2005	**0.09**	0.17	29	6/27/2005	**0.52**	0.62	107	11/9/2005	**2.09**	2.13	365
Site 10	9/22/2005	**0.18**	0.18	31	10/29/2004	**0.58**	0.58	100	6/24/2005	**0.83**	0.83	143
Site 11	9/13/2005	**0.15**	0.15	26	11/3/2004	**0.62**	0.62	106				

	Grid Fishing				Snorkel Survey				Site cfsm Conversions
	Date	**cfsm**	**Mcfsm**	**Mcfs**	**Date**	**cfsm**	**Mcfsm**	**Mcfs**	
Site 1	7/26/2005	**0.37**	0.51	87					**y=0.6189x^0.7793**
Site 2	7/21/2005	**0.47**	0.71	121					**y=0.6189x^0.7793**
Site 3	7/22/2005	**0.48**	0.62	107					**y=0.9437x^1.454**
Site 4	8/17/2005	**0.31**	0.46	79					**y=0.9437x^1.454**
Site 5	7/29/2005	**0.27**	0.46	79					**y=.5947x^1.0369**
Site 6					8/9/2005	**0.16**	0.28	48	**y=0.966x^1.4159**
Site 7	7/27/2005	**0.29**	0.43	73					**y=0.966x^1.4159**
Site 8					8/4/2005	**0.46**	0.57	97	**y=0.9649x^1.314**
Site 9					8/10/2005	**0.16**	0.26	44	**y=0.9649x^1.314**
Site 10					8/5/2005	**0.49**	0.49	84	**y=x/171.3**
Site 11					8/10/2005	**0.26**	0.26	44	**y=x/171.3**

Mcfs - USGS gauge cubic feet/second

Mcfsm - USGS gauge cfs/171.3

cfs - site cubic feet/second

cfsm - (site cubic feet/second)/watershed

Site Details

The following information was recorded at the time of mapping for each HMU.

Date: Date of mapping
HMU Number: Unique sequential numbering for that day and site
HMU Type: See HMU Definitions section
Choriotop: See Choriotop Definitions section
Fishing (Yes/No): Was the HMU was mapped during fishing survey?
Low Gradient (Yes/No): Was the HMU mapped on a low-gradient river?
Wetted Width: The current wetted width (meters) obtained using a range finder.
Bankfull Width: The bank-full width (meters) obtained using a range finder.

HMU Definitions

The following are brief definitions for the Hydromorphological Units

Backwater – Slack area along a channel margin caused by eddies behind obstructions, the development of sandbars during flood events, or through the abandonment of older channels.
Cascade – Stepped rapids with very small pools behind boulders and small waterfalls.
Fast Run – Uniform fast-flowing stream channel.
Glide – Moderately shallow stream channel with laminar flow. Lacks pronounced turbulence, and exhibits flat streambed morphology.
Plunge Pool – Area where main flow passes over a complete channel obstruction and drops vertically to scour the streambed.
Pool – Deep water impounded by a channel blockage or partial channel obstruction. Slow velocities with a concave streambed shape.
Rapid – Higher gradient reach than a riffle, with faster current velocity, coarser choriotop, more surface turbulence, and convex streambed morphology.
Riffle – Shallow stream reach with moderate current velocity, some surface turbulence, high gradient, and convex streambed morphology.
Ruffle – De-watered rapid in transition to either run or riffle.
Run – Deeper stream reach with moderate current velocity, but no surface turbulence (laminar flow). Streambed is longitudinally flat and laterally concave.
Side Arm – Channel around an island, smaller than half the width of the river, frequently at a different elevation than the main channel.

Choriotop Definitions

The following are choriotop classification categories according to Austrian Standard OEN M6232, specifically developed for benthic habitat classification. They generally describe bin grain-size and other possible organic substrate. When conducting a hydrologic survey we consider an area of one square meter (with the dipstick at its center) and record the dominant choriotop type. There may be a mix of grain sizes included in this square meter, but in most

cases, a mean particle size will be apparent. When conducting an HMU survey, the mean particle size of the entire HMU will be considered when selecting a choriotop.

1) **PELAL** - silt, loam, clay and sludge (<0.063 mm).
2) **PSAMMAL** – sand (0.063 - 2 mm).
3) **AKAL** – medium to fine gravel (0.2 - 2 cm).
4) **MICROLITHAL** – coarse gravel with mixture of medium to fine gravel (2 - 6.3 cm).
5) **MESOLITHAL** – fist- to hand-sized cobbles with a mixture of medium to fine gravel (6.3 - 20 cm).
6) **MACROLITHAL** – coarse blocks, head-sized cobbles, mix of cobbles, gravel and sand (20 - 40 cm).
7) **MEGALITHAL** – large cobbles, blocks, and bedrock (>40 cm).
8) **GIGALITHAL** – bedrock.
9) **SAPROPEL** – organic sludge.
10) **DETRITAL** – deposits of particulate organic matter. Different types are CPOM = coarse particulate matter (e.g. fallen leaves) and FPOM (fine particulate organic matter).
11) **DEBRIS** – organic and inorganic matter deposited within the splash zone area by wave motion and changing water levels (e.g. mussel and snail shells).
12) **PHYTAL** – submerged plants, floating stands or mats, lawns of bacteria or fungi, and tufts, often with aggregations of detritus, moss or algal mats. (INTERPHYTAL = habitat within a vegetation stand or plant mat).
13) **XYLAL** – tree trunks, roots, branches or other dead wood.

Embeddedness Definitions

Embeddedness refers to the cohesive nature of the choriotop. The guidelines followed for selecting the choriotop type while conducting hydrologic surveys also applies to selecting Embeddedness. The characteristics in a one-meter grid around the dipstick are recorded as the mean grid characteristic.

(L) **Loose** – dislodges easily when stepped on or kicked. (e.g. sand, gravel, detritus)
(E) **Embedded** – river-bottom materials are firmly in place and only dislodged with great effort, typical result of stream armoring.
(S) **Solid** – river section is flowing over exposed bedrock, large slabs of rock, or an artificial surface.

Attributes

Mapping teams indicate whether the following are present or abundant: Boulders, Riprap (manufactured concrete erosion control), Overhanging Vegetation, Submerged Vegetation, Canopy Shading, Undercut Bank, Woody Debris, and Shallow Margin.

Shore Properties

Properties of the river's banks are recorded individually for each bank. *Left Shore Use* looking downstream; then the process repeated for the *Right Shore Use*. *Shore Use* refers to the

adjacent land-use for that section, not necessarily the characteristic of embankment: Agriculture, Field, Forested, Pasture, Residential, Road, Shrub brush, or Urbanized. Other characteristics recorded are: Eroded, Stabilized (non-rip-rap erosion control), Irregular Shoreline, and Clay.